arranged to measure a respiratory motion signal (B) which is dependent on the respiratory motion.

16. (Amended) The X-ray device as claimed in claim 15, wherein there is provided a signaling device for informing the patient that a desired respiratory motion phase (B_1) has been reached.

17. (Amended) The X-ray device as claimed in claim 15, wherein the means for measuring the respiratory motion signal (B) include one of: an ultrasound device, an abdominal belt for measuring the motion of the diaphragm, and a resistance measuring device for measuring the resistance of the abdominal region of the patient.

REMARKS

This Amendment is submitted in response to the Office Action which issued in this case on December 13, 2001. Reconsideration is respectfully requested.

Response To Rejections Under 35 USC § 102

Claims 1-5, 7, 12-14 were rejected in the Office Action under 35 USC § 102(b) as anticipated by US Patent No. 5,751,782 to Yoshitome. The Examiner asserts that Yoshitome

discloses a method and device for acquiring a three-dimensional image data set of a periodically moving organ by means of an x-ray device including a source and detector, a motion signal acquired simultaneously with the acquisition of projection data sets from different x-ray positions during a low-motion phase, where only projection data acquired during the same low-motion phases are selected and used.

In response, applicants respectfully assert that claims 1-5, 7 and 12-14 are not anticipated by Yoshitome for at least the following reasons.

Applicants' inventions of independent method claim 1 and independent x-ray device claim 12 set forth method and apparatus for the acquisition of three-dimensional image data set of a periodically moving organ of the body of a patient. The acquisition includes <u>irradiating the organ</u> by means of an X-ray device which includes an X-ray source and an X-ray detector, <u>detecting</u> a motion signal (H, B) which is related to the periodic motion of the body organ simultaneously with the acquisition of projection data sets (D_0, D_1, ..., D_{16}), <u>successively acquiring</u> the projection data sets (D_0, D_1, ..., D_{16}) required for the formation of <u>a</u> three-dimensional image data set [are successively acquired] from different X-ray positions (p_0, p_1, ..., p_{16})<u>,</u> which <u>x-ray positions</u> are situated in one plane, <u>controlling</u> the X-ray device [is

controlled] by means of the motion signal (H, B) to acquire a projection data set (D_0, D_1, ..., D_{16}) during a low-motion phase of the body organ in each X-ray position (p_0, p_1, ..., p_{16}) required for the formation of the three-dimensional image data set, and using the projection data sets (D_0, D_1, ..., D_{16}) acquired during the low-motion phases for the formation of the three-dimensional image data set.

Yoshitome discloses apparatus where a signal defining or defined by an organ phase, irrespective of whether it is a fast or slow motion phase, is utilized to periodically trigger acquisition of projection data sets while varying the position of the source and detector. Yoshitome calls out the acquisition of spiral CT data, which is derived during continuous rotation, clearly distinguished from the periodic rotation which is such an essential element of applicants' independent claims.

The Yoshitome inventions are distinct from applicants' inventions as claimed. The Yoshitome data are acquired continuously as spiral CT data, and are not acquired for x-ray positions situated in one plane. In consequence, applicants respectfully assert that independent claims 1 and 12, and claims 2-5, 7 and 13-14 which depend respectively therefrom, are not anticipated by Yoshitome. That is, claims 1-5, 7 and 12-14 are not anticipated by Yoshitome under 35

USC § 102(b), and applicants request withdrawal of the claim rejections thereunder.

Response To Rejections Under 35 USC § 103

Claims 6, 8, 9, 11, 15 and 17 were rejected in the Office Action under 35 USC § 103(a) as obvious over Yoshitome as applied to claims 1, 7 and 12, above, and further in view of US Patent No. 3,871,360 to Van Horn. The Examiner asserts that Yoshitome discloses the method and device as asserted with respect to the rejections under Section 102(b), that Yoshitome does not disclose using a respiratory signal to acquire data and correct data acquired in different respiratory motion phases from individual selected x-ray positions, but that Van Horn teaches means for utilizing a respiratory motion signal, such as a resistance measuring device, to ensure that data are acquired during the same motion phase, and to correct data acquired in different respiratory motion phases from "individual selected x-ray positions", and that it would have been obvious to have made the respiratory adaptations of Van Horn to Yoshitome to realize images not blurred by heart or lung motion.

In response, applicant respectfully asserts that claims 6, 8, 9, 11, 15 and 17 are not obvious by Yoshitome in view of Van Horn for at least the following reasons.

While Yoshitome teaches use of a respiration signal to acquire data at a fixed phase of an organ cycle, and to correct data from different phases based on correlation of the acquired data with each phase in a respiratory cycle, Yoshitome performs said acquisition using continuous rotation. Moreover, Van Horn at col. 5, lines 48-54, does not set forth any teaching or suggestion regarding successively acquiring projection data sets (D0, D1, ... , D10) from x-ray positions situated in one plane.

In contrast, applicants' claim 1 method and claim 12 x-ray device utilize periodic acquisition of data, and, as set forth in claims 6, 8, 9, 11, 15 and 17, use a respiratory signal as the motion signal to control the x-ray device to acquire projection data sets, periodically during low motion phases of an organ for x-ray positions situated in one plane.

While Van Horn may teach the use of a respiratory motion signal, Van Zorn does not do so to acquire 3-D image data of a periodically moving organ. That is, Van Zorn teaches monitoring respiratory and cardiac cycles to time a selected physical state. Van Zorn includes input circuitry to provide signals representative of the respiratory cycle, and respiratory timing circuitry for processing the signals and generating windows corresponding to selected portions of the successive respiratory cycles.

Van Zorn's Fig. 1 shows a synchronizer of the invention including a nuclear camera, and requires electrodes 14 connected to an impedance plethysmograph 30. Applicants inventions as claimed do not require such hardware. Moreover, as set forth above in the argument for the patentability of claims 1-5, 7 and 12-14, Neither Van Zorn nor Yoshitome disclose the acquisition of data derived during a periodic low motion phase of the organ from x-ray positions situated in the same plane using a respiratory signal.

Nor does the combination of Yoshitome and Van Zorn realize applicants' inventions as claimed. That is, even the combination of Van Zorn and Yoshitome does not realize an x-ray device, and method of operating same, which is based on successive acquisition of data in sync with a respiratory signal from x-ray positions situated in one plane.

Accordingly, claims 6, 8, 9, 11, 15 and 17 are not obvious by Yoshitome in view of Van Zorn under 35 USC § 103(a), and applicants, therefore, respectfully request withdrawal of the rejection of claims 6, 8, 9, 11, 15 and 17, thereunder.

Claims 10 and 16 were rejected under 35 USC § 103(a) as unpatentable over Yoshitome in view of Van Horn, and further in view of US Patent No. 5,482,042 to Fujita. The Examiner asserts that Yoshitome does not disclose use of a respiratory

Van Zorn's Fig. 1 shows a synchronizer of the invention including a nuclear camera, and requires electrodes 14 connected to an impedance plethysmograph 30. Applicants inventions as claimed do not require such hardware. Moreover, as set forth above in the argument for the patentability of claims 1-5, 7 and 12-14, Neither Van Zorn nor Yoshitome disclose the acquisition of data derived during a periodic low motion phase of the organ from x-ray positions situated in the same plane using a respiratory signal.

Nor does the combination of Yoshitome and Van Zorn realize applicants' inventions as claimed. That is, even the combination of Van Zorn and Yoshitome does not realize an x-ray device, and method of operating same, which is based on successive acquisition of data in sync with a respiratory signal from x-ray positions situated in one plane. Accordingly, claims 6, 8, 9, 11, 15 and 17 are not obvious by Yoshitome in view of Van Zorn under 35 USC § 103(a), and applicants, therefore, respectfully request withdrawal of the rejection of claims 6, 8, 9, 11, 15 and 17, thereunder.

Claims 10 and 16 were rejected under 35 USC § 103(a) as unpatentable over Yoshitome in view of Van Horn, and further in view of US Patent No. 5,482,042 to Fujita. The Examiner asserts that Yoshitome does not disclose use of a respiratory

motion signal to inform a patient, that Fujita does, and it would have been obvious to have a respiratory signal for the patient of Fujita with the Yoshitome device in view of Van Horn, by motivation to have better user control for respiration to time data acquisition relative to breathing shown by Fujita.

In response, applicants respectfully assert that claims 10 and 16 are not obvious by Yoshitome in view of Van Horn In view of Fujita for at least the following reasons.

Applicants claims 10 and 16 are set forth above.

Fujita discloses a medical imaging apparatus with a respiration depth detecting device. The apparatus acquires projection data continuously before and after a breathing spell by the patient in order that the positional relationship between organs can be made constant.

Fujita does not teach applicants' inventions as claimed. For that matter, applicants' inventions do not utilize a respiratory signal to inform the patient, as asserted by the Examiner. Moreover, A device comprised of combined teaching of Yoshitome and Van Zorn would have no need or use for an indication means as taught by Fujita to coordinate acquisition of data from a periodically moving organ from x-ray positions situated in the same plane, as does applicants' inventions as claimed.

That is, while there is no teaching or suggestion in any of Yoshitome, Van Zorn or Fujita for combining the art taught to realize inventions such as those set forth in claims 10 and 16, even combining the references would still not realize the inventions as claimed. Accordingly, applicants respectfully assert that claims 10 and 16 are not obvious under Section 103(a) by Yoshitome in view of Van Zorn and Fujita, and requests withdrawal of the same claims rejections thereunder.

ATTACHMENT: All of the pending claims are amended as follows:

1. (Amended) A method of acquiring a three-dimensional image data set of a periodically moving organ [(11)] of the body of a patient, comprising the steps of:

irradiating the organ [(5)] by means of an X-ray device [(1)] which includes an X-ray source [(2)] and an X-ray detector [(3)],

detecting a motion signal (H, B) which is related to the periodic motion of the body organ [(11) being acquired] simultaneously with the acquisition of projection data sets (D_0, D_1, ..., D_{16}),

successively acquiring [characterized in that] the projection data sets (D_0, D_1, ..., D_{16}) required for the formation of a [the] three-dimensional image data set [are successively acquired] from different X-ray positions (p_0, p_1, ..., p_{16}), which x-ray positions are situated in one plane,

controlling [that] the X-ray device [is controlled] by means of the motion signal (H, B) to acquire [in such a manner that] a projection data set (D_0, D_1, ..., D_{16}) [is acquired] during a low-motion phase of the body organ [(11)] in each X-ray position (p_0, p_1, ..., p_{16}) required for the formation of the three-dimensional image data set, and

using [that] the projection data sets (D_0, D_1, ..., D_{16}) acquired during the low-motion phases [are used] for the formation of the three-dimensional image data set.

2. (Amended) The [A] method as claimed in claim 1, wherein [characterized in that] only the projection data sets (D_0, D_1, ..., D_{16}) that have been acquired during the same motion phases (H_1, B_1) are selected and used.

3. (Amended) The [A] method as claimed in claim 1, wherein [characterized in that] the various X-ray positions (p_0, p_1, ..., p_{16}) are successively occupied in an X-ray cycle (R_1), that a plurality of X-ray cycles (R_1, R_2) are successively completed, and [that] the X-ray device [(1)] is controlled by means of the motion signal (H, B) in such a manner that each X-ray cycle (R_1, R_2) commences in a different phase of motion (H_1, H_2; B_1, B_2, B_3) of the body organ [(11)].

4. (Amended) The [A] method as claimed in claim 1, wherein [characterized in that] the X-ray device [(1)] is controlled by means of the motion signal (H, B) [in] such [a manner] that projection data sets (D_0, D_1, ..., D_{16}) are acquired only during low-motion phases (H_1; B_1, B_3) of the body organ[(11)].

5. (Amended) The [A] method as claimed in claim 1, wherein [characterized in that] the X-ray device [(1)] is controlled by means of the motion signal (H, B) [in] such [a manner] that the X-ray source [(2)] is switched on so as to acquire projection data sets (D_0, D_1, ..., D_{16}) exclusively during low-motion phases (H_1; B_1, B_3) of the body organ[(11)].

6. (Amended) The [A] method as claimed in claim 1, wherein [characterized in that] a respiratory motion signal (B) which is dependent on the patient's respiration is acquired as a motion signal.

7. (Amended) The [A] method as claimed in claim 1, wherein [characterized in that] a cardiac motion signal (H)[, notably an electrocardiogram,] which is dependent on the motion of the heart is acquired as the motion signal.

8. (Amended) The [A] method as claimed in claim 7, wherein [characterized in that] in addition to the cardiac motion signal (H) there is acquired a respiratory motion signal (B) which is dependent on the respiratory motion, and [that] the respiratory motion signal (B) is used to ensure that only the projection data sets (D_0, D_1, ..., D_{16}) that have been acquired

during the same respiratory motion phases (B_1) are used to form the three-dimensional image data set.

9. (Amended) The [A] method as claimed in claim 8, wherein [characterized in that] the respiratory motion signal (B) is used to correct, during the formation of the three-dimensional image data set, the projection data sets (D_0, D_1, ..., D_{16}) that have been acquired in different respiratory motion phases (B_1, B_2, B_3) and the shifts in position of the body organ [(11)] resulting therefrom.

10. (Amended) The [A] method as claimed in claim 6, wherein [characterized in that] the respiratory motion signal (B) is used to inform the patient [(5)] that a desired respiratory motion phase (B_1) has been reached during which the acquisition of the projection data sets (D_0, D_1, ..., D_{16}) takes place.

11. (Amended) The [A] method as claimed in claim 1, wherein [characterized in that] the motion signal (H, B) is used to control the X-ray device [(1)] in such a manner that projection data sets (D_0, D_1, ..., D_{16}) are acquired from individual, selected X-ray positions (p_0, p_1, ..., p_{16}).

12. (Amended) An X-ray device[, notably for carrying out the method claimed in claim 1,] which includes:

an X-ray source [(2)] and an X-ray detector [(3)] for the acquisition of a plurality of projection data sets (D_0, D_1, ..., D_{16}) from different X-ray positions (p_0, p_1, ..., p_{16}) and for the formation of a three-dimensional image data set of a periodically moving organ [(11)] of the body of a patient (5) from the projection data sets (D_0, D_1, ..., D_{16}), and

[also includes] means [(7, 8, 9, 10)] for measuring a motion signal (H, B) which is related to the periodic motion of the body organ [(11)] and is acquired simultaneously with the acquisition of the projection data sets (D_0, D_1, ..., D_{16}),

wherein [characterized in that] there is provided an arithmetic and control unit [(6)] for controlling the X-ray device [(1)] and for forming the three-dimensional image data set [in] such [a manner] that the projection data sets (D_0, D_1, ..., D_{16}) required for the formation of the three-dimensional image data set are successively acquired from different X-ray positions (p_0, p_1, ..., p_{16}) which are situated in one plane,

wherein [that] a projection data set (D_0, D_1, ..., D_{16}) is acquired during a low-motion phase of the body organ

[(11)] in each X-ray position (p_0, p_1, ..., p_{16}) required for the formation of the three-dimensional image data set, and

wherein [that exclusively] the projection data sets (D_0, D_1, ..., D_{16}) acquired during the low-motion phases are used exclusively for the formation of the three-dimensional image data set.

13. (Amended) The [An] X-ray device as claimed in claim 12, wherein [characterized in that] the means [(7, 8)] for measuring the motion signal are arranged to measure a cardiac motion signal (H) which is dependent on the cardiac motion.

14. (Amended) The [An] X-ray device as claimed in claim 12, wherein [characterized in that] the means [(7, 8)] for measuring the cardiac motion signal (H) include one of: an electrocardiography device and [or] a pulse oxymetry device.

15. (Amended) The [An] X-ray device as claimed in claim 12, wherein [characterized in that] the means [(9, 10)] for measuring the motion signal are arranged to measure a respiratory motion signal (B) which is dependent on the respiratory motion.

16. (Amended) The [An] X-ray device as claimed in claim 15, wherein [characterized in that] there is provided a signaling device [(12)] for informing the patient that a desired respiratory motion phase (B_1) has been reached.

17. (Amended) The [An] X-ray device as claimed in claim 15, wherein [characterized in that] the means [(9, 10)] for measuring the respiratory motion signal (B) include one of: an ultrasound device, an abdominal belt for measuring the motion of the diaphragm, and [or] a resistance measuring device for measuring the resistance of the abdominal region of the patient [(5)].

Conclusion

In concluding, applicants restfully assert that claims 1-17 are patentable over the art cited, and request allowance of claims 1-17 and passage to issue of this application.

Respectfully submitted,

By____________________

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